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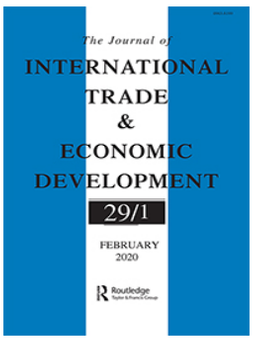

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Firm heterogeneity and exports in the Netherlands: Identifying export potential beyond firm productivity

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ABSTRACT

According to the Melitz [2003. 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity.' *Econometrica* 71: 1695–1725] model, potential exporters have to be sufficiently productive to overcome the entry costs of foreign markets. Once firms pass this productivity threshold, they *all* export. However, empirical evidence indicates that a substantial share of highly productive top-performing firms does not export. In this paper, we focus specifically on this group of high-performing non-exporters and identify the factors that prevent them from successfully exporting. We employ a large Dutch administrative dataset containing both small and large firms in services and manufacturing for the period 2010–2016. Our main findings are two-fold. First, controlling for high productivity identifies other factors that need to be fulfilled for exporting firms. Firm size, import status, and foreign ownership are important determinants of a firm's future export activity. Second, firm location is crucial. A location in more peripheral areas increases the probability that high-productive firms do not export, whereas a location close to the border increases export probabilities.

KEYWORDS Firm heterogeneity; productivity; export behavior; location

JEL CLASSIFICATIONS F12, F14

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1. Introduction

Ever since the empirical work of Bernard and Jensen (1995, 1999), it is well-known that firms within industries not only differ with respect to export status, but also in various other dimensions such as productivity, employment, skill intensity, value added per worker, number of products, capital intensity, and many other firm characteristics (Bernard et al. 2007).[1] Compared to non-exporting firms, exporting firms perform differently on all relevant aspects: they are more productive, pay higher wages, are more innovative, and are more capital-intensive.[2] Moreover, exports are strongly concentrated within the group of large firms: in the USA the top 1% of largest firms captures some 80% of total exports; in Germany the top 1% captures some 60% of total exports (WTO 2008).

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According to the theoretical model developed by Melitz (2003), productivity is the crucial factor. Firms have to be productive enough to cover the market entry costs of foreign markets. Once firms pass a certain productivity threshold, they all export. Empirical research, however, indicates that this is not the case; high-productive firms often do not export, while some low-productive firms are able to enter foreign markets (Bernard et al. 2012).

Our focus is not on the comparison of exporters versus non-exporters in general, but we concentrate specifically on the group of high-performing firms. Controlling for high productivity identifies other factors that need to be fulfilled in order to become exporters. Or to put it differently, what additional factors raise entry costs for these high-performing non-exporters, that prevents them from successfully expanding into foreign markets?[3] The observation that firms might encounter different entry costs is not new (see for example, Das, Roberts, and Tybout 2007; Eaton, Kortum, and Kramarz 2011; Armenter and Koren 2015). The contribution of our paper is to try to find evidence of the heterogeneity in export decisions within Dutch firms, conditional on high productivity. Furthermore, compared to the existing literature we employ a more comprehensive dataset which includes large and small firms in both the services and the manufacturing sector.

Our main findings are two-fold. First, in line with the existing empirical literature on firm-export performance, high productivity is indeed an important, but clearly not a sufficient condition for exporting. Other firm characteristics of importance are firm size, import status and foreign ownership. The importance of firm size is slightly surprising to some degree as it is a substitute for productivity in the Melitz model, but in addition it also can be an indicator of access to export finance or the availability of resources to set up a foreign sales network. Interestingly, the services sector can, by-and-large, be described by the same model that also describes the goods sector, but is also different in various important dimensions. Worker skill, capital intensity, various financial variables and the density of firms in their region matter for the export decisions of service firms (see also Breinlich and Criscuolo 2011), but we find no such relationship for manufacturing firms. Second, we find that firm location is crucial. A location in peripheral areas goes along with a lower chance for even high-productive firms to export, the reason might be significantly higher entry costs. In particular, a location in the Northern part of the Netherlands is a drawback and would thus add to foreign entry costs, whereas firms close to the Dutch–Belgian and/or Dutch–German border as well as firms in areas with a high exporter density have a higher export probability. Interestingly, a location in the dense urbanized western part of the Netherlands only adds to the probability that a firm starts exporting to countries outside the EU.

Although the model explains and predicts export decisions of firms to a certain degree, a substantial unexplained firm-level heterogeneity remains. Future research would do well to target these firms for more in-depth research. Why do so many highly productive firms still not export, even though they appear to meet all relevant requirements for exporting? Is it purely a lack of foreign opportunities for these firms, or are other information, organizational or managerial barriers at play? Obtaining more insights into the barriers which these firms encounter would be valuable, as they form a potentially interesting group for targeted policies.

The structure of the paper is as follows. In Section 2 we motivate the method and research questions, and discuss the related literature. Section 3 describes the dataset,

Section 4 presents the main results and Section 5 discusses some caveats. Section 6 presents our conclusions.

2. Related literature and method

The Melitz (2003) model has a clear intuitive appeal and straightforward empirical implications. In this model a new firm, in a monopolistically competitive market, that considers entering the market is uncertain about its productivity level. Before entering the market it has to pay a market entry fee. Only after it has entered – and paid the sunk costs – it discovers its productivity level that is randomly allocated to the firm. Once the productivity level is revealed to the firm, it finds out whether that productivity level is high enough to cover production costs. If this is not the case, it exits the market. Each firm in the market has to go through this process and because productivity levels are drawn from a probability distribution firms differ in terms of productivity and are heterogeneous. By assuming that fixed production costs are higher in the export market than in the domestic market (setting up a sales network in a foreign market is more expensive than in a domestic market) a ranking of firms results; firms have to be productive enough to survive in the (domestic) market and only the more productive firms can become exporters because these firms can cover the higher entry costs in the foreign market (see Bernard et al. 2012; Melitz and Redding 2014; Helpman 2018 for recent surveys of the literature).

Empirical research has in general confirmed the predictions of the model; Productivity drives exports, and firms have to be productive enough to cover the higher entry cost of foreign markets. Pavcnik (2002) finds that, following Chilean trade liberalization, roughly two-thirds of the 19% increase in aggregate productivity is caused by the survival of the most productive firms. Similar results are found by Trefler (2004) following a reduction in trade barriers in Canada, or by Bernard, Jensen, and Schott (2006) for trade barrier reductions in the USA (see Wagner 2007 for a survey). For developing countries comparable results are found (see e.g. Sharma and Mishra 2011 for evidence on India). The central ideas from Melitz (2003) can easily be extended; firms first export to nearby markets and then to markets that are further away, because fixed entry costs increase with distance (Holmes and Stevens 2012).[4] Also different modes of entry can easily be incorporated, such as FDI by assuming that the market entry cost of becoming a multinational is higher than the costs of exporting (Helpman, Melitz, and Yeaple 2004; Helpman 2018 for a survey). Furthermore, different sectors could face different fixed entry costs. In general, entry cost heterogeneity has been observed in various applications (see, for example, Bernard, Redding, and Schott 2007; Das, Roberts, and Tybout 2007; Eaton, Kortum, and Kramarz 2011; Armenter and Koren 2015).

What matters for our present purposes is that cut-off levels are market and sector specific; markets that are further away have higher cut-off values, and these cut-off values are – most likely – sector specific (because of the type of product). What is also clear from the data is that in many countries the respective firm productivity distributions overlap. This implies that at the tails of the distribution, one observes high-performing firms that despite passing the export productivity threshold do *not* engage in exporting (and/or enter more distant markets or engage in FDI). One interpretation of this observation is that besides *sector* or *market* specific entry costs also firm-specific entry costs to trade exist. These barriers prevent firms from becoming exporters even when they seem productive enough to cover the sector and market specific entry costs. We are

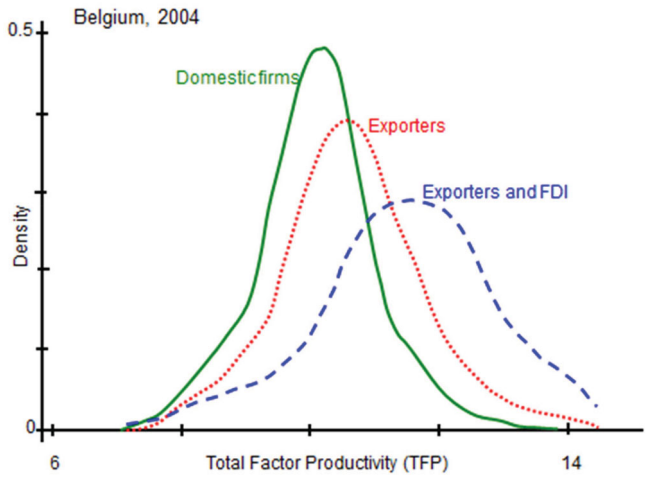

Figure 1. Firm productivity in Belgium for domestic, exporting and exporting/FDI firms. Source: Mayer and Ottaviano (2007, 21, Figure 4).

especially interested in entry barriers for high-performing firms. Conditional on high performance, we focus on non-exporters.

Figure 1 shows a representative outcome from the literature, ranking of firms from low to high total factor productivity (TFP) and how the three productivity density distributions overlap; implying that some very productive firms do not engage in exporting or FDI, but are only active domestically.[5] The latter observation is the topic of this paper: what other factors, besides firm productivity, determine the export decision? Note, again, that we do not assume in our analyses that cut-off values are homogeneous; they might differ for separate markets and/or sectors. Our main question is whether (non-) exporting highly performing firms, on a given market and within a specific sector, differ systematically in other dimensions than just their productivity? If we can determine some of these dimensions, we can increase our knowledge with respect to factors that contribute or prevent firms to become exporters.

3. Data and methodology

3.1. Data description

Central to our analysis are firm-level data for the Netherlands for firms in both the manufacturing and services sector. We combine administrative data from a number of sources. The General Business Register (GBR) maintained by Statistics Netherlands (CBS) includes information on sector, firm location and number of employees for every firm with operations in the Netherlands. Data on firm exports is taken from the value-added tax declarations. Finally, financial data of the balance sheet and the income statements are taken from the corporate income tax declarations. Each of the three datasets covers the large majority of the Dutch firms in all sectors, apart from the financial sector, the agricultural sector and parts of the non-profit sector.[6] Finally, information on the location of the Ultimate Controlling Institutional unit of each firm is retrieved from the Inward Investment database.

Table 1. Sector distribution; number of firm-year observations.

Nace Rev.2 sector code	Sector name	No. of obs.	Percent
C	Manufacturing	45,343	15.69
F	Construction	38,055	13.17
G	Wholesale and Retail trade	93,122	32.22
H	Transportation and storage	18,881	6.53
I	Accommodation and food services	17,804	6.16
J	Information and communication services	17,371	6.01
M	Professional and technical activities	37,31	12.91
N	Administrative activities	21,137	7.31
	Total number of observations	289,021	100

The above procedure results in 1,510,959 firm-year observations for the period 2010–2016.[7] We pick this period as there were various changes in definitions in 2009, which altered the coverage of firms in the sample.[8] We filter the data for unrealistic values, that is, firms that have negative imports or exports, negative assets, report exactly the same values with respect to key variables such as revenue and wages paid for two or more consecutive years, or have unrealistically high values for productivity (for example, hundreds of millions of sales per worker).[9] Furthermore, as in Groot and Weterings (2013), we drop firms with fewer than five employees, firms in sectors with very few firms[10] (e.g. mining) and firms in the utility and non-profit sector (e.g. energy and schooling).[11] The above procedure results in 289,021 firm-year observations for the period 2010–2016. The size requirement of five employees is by far the most stringent, and is responsible for 88% of loss of observations measured in firm-years.[12]

Table 1 shows how the observations are distributed over the various sectors.[13] For all firms in this sample we can calculate TFP (see below), know their export status and have detailed information on firm characteristics.

3.2. Descriptive statistics on export behavior

Figure 2 provides some descriptive statistics about the degree of export and FDI activities of Dutch firms. We distinguish between non-exporters, firms exporting exclusively to EU countries, firms exporting exclusively to non-EU countries, firms exporting to both EU and non-EU countries, and firms engaging in FDI (multinationals). As can be seen from Figure 6, a relatively large percentage of the Dutch firms are internationally active. Nonetheless, in all sectors a substantial number of firms are active only domestically, which is consistent with existing empirical findings. For the firms that do export, the resulting sectoral share of firms that export to non-EU countries relative to firms that export only to EU countries is typically smaller than one (with the exception of *manufacturing* and *wholesale and retail trade*), and only a very small fraction of firms is engaged in FDI (see also Bernard et al. 2012). These observations can be understood with the Melitz (2003) model and are consistent with the assumption that market entry becomes systematically more expensive with internationalization status. Figure 6 also reveals that sectors differ from each other and that different markets – EU and non-EU markets are likely to have different entry costs.

Not only industry, but also firm location may matter for the export status of firms. As location variable we take the NUTS1 level, which divides the Netherlands into four parts: North, East, South and West.[14] The West contains the economic center of the

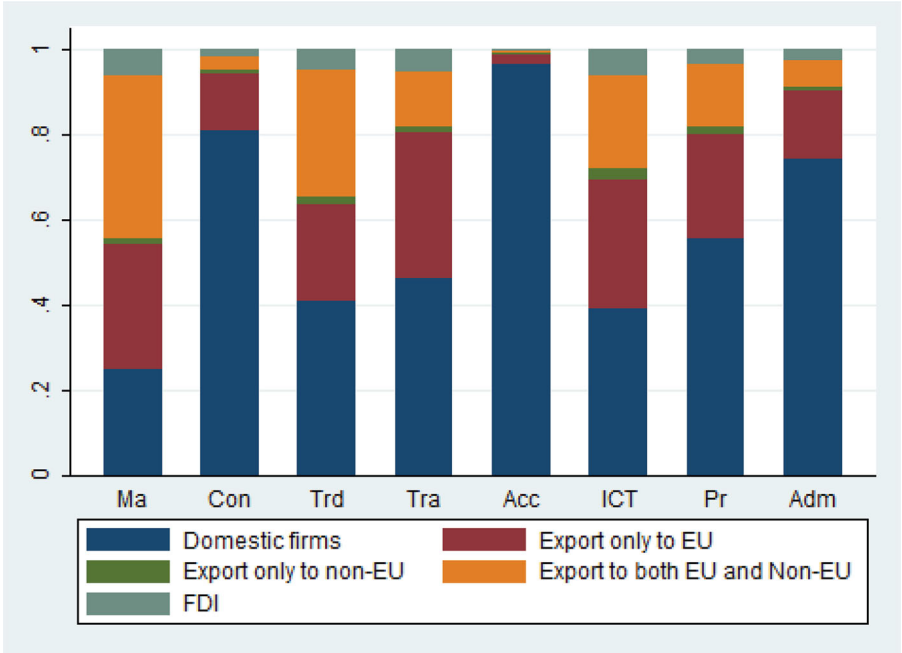

Figure 2. Percentage of firms engaged in exporting by sector.

Notes: Firms by internationalization status. Labels are the following: (Ma = Manufacturing, Con = Construction, Trd = Wholesale and Retail trade, Tra = Transport and Storage, Acc = Accommodation and Food services, ICT = Information Technology, PR = Professional Services and Adm = Administrative services). If a firm engages in FDI (e.g. has taxable income from foreign operations) it is classified as FDI, regardless of export status.

Netherlands (the so-called Randstad area), main international airport (Amsterdam) and harbor (Rotterdam), and the four largest cities (Amsterdam, Rotterdam, The Hague and Utrecht). Of these four regions, the West is the most distant from the border. Parts of North and East border Germany, whereas large parts of the South are relatively close to the Belgium as well as German border. Substantial variation exists in the export performance of the regions. Figure 3 shows the difference in the percentage of firms that exports by industry–location pair, compared to the national industry average. A value of 1 indicates that the percentage of firms that exports in a certain industry in a certain NUTS1 region is the same as on the national level. Figure 3 shows clear differences in the export probabilities between regions; firms in the North export less frequently than the national average in every single sector, whereas firms in the South have a higher than average export probability in every single sector. Moreover, the differences in industry-composition can only explain underperformance of regions to a limited extent. A region with a below-average export performance in one industry is highly likely to have a below-average export performance in all the other industries. On the other hand, Figure 3(b) shows that no such large differences in average productivity are visible between the regions.[15]

Finally, in order to limit the amount of space and due to the limited numbers of observations in certain industry-region pairs, we will present results for the aggregated *manufacturing* sector (NACE Rev.2 codes 10–33) and the *services* sector (NACE Rev.2 codes 41–53/58–63/and 68–82) in the remainder of this paper.[16]

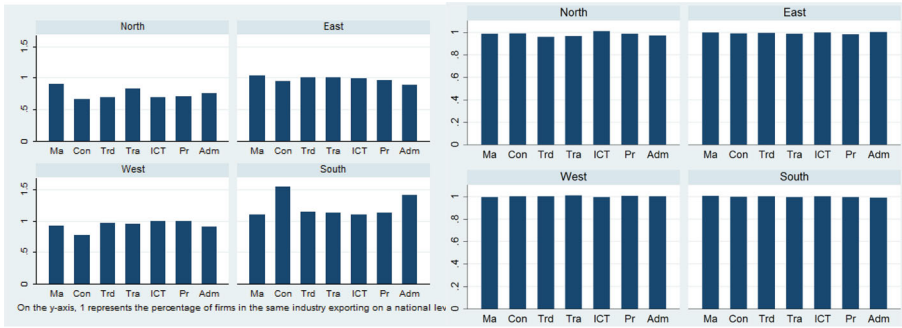

Figure 3. Regional differences in export behavior (a) and productivity (b) by industry.

Notes: *y*-axis in figure (a) defined as (% of firms exporting$_{ir}$/% of firms exporting$_i$), where *r* is the region and *i* is the industry (Ma = Manufacturing, Con = Construction, Trd = Wholesale and Retail trade, Tra = Transport and Storage, ICT = Information Technology, PR = Professional Services and Adm = Administrative services). *y*-Axis in figure (b) is the average productivity within a sector in a given region, divided by the average national productivity in that sector. See Section 3.3 for the way in which productivity is calculated.

3.3. Productivity

A key variable in the analysis is firm productivity. We use the method as developed by Levinsohn and Petrin (2003) which has become a standard method to measure TFP (and deals with the fact that the error term is most likely correlated with factor inputs).[17] It measures TFP as a 'residual' – that is, that portion of output growth that is not explained by factor input growth, with the key variables capital and labor (see Feenstra (2016) for a discussion). The Levinsohn and Petrin (2003) methodology relies on a proxy variable to control for that part of the error term that could be correlated with factor inputs.[18] For labor input, total wages are used to ensure that we correct for differences in worker quality between firms (see also Möhlmann and de Groot 2011). Total material assets are used as capital input. Due to data availability, we employ the variable 'costs of sales' as a proxy variable instead of costs of energy or costs of materials as in Levinsohn and Petrin (2003). The impact of this difference in proxy appears rather small, as the correlation in TFP is 0.96 in the case of a subset of manufacturing firms for which we observe both proxies.

As the production technology most likely differs between individual sectors, we estimate a separate production function based on the Levinsohn and Petrin (2003) approach for each of the 45 Nace Rev.2 industries listed in Appendix 1. This allows the coefficients on capital and labor to vary between industries, both within the manufacturing as well as the service sector. As we are interested in the effect of productivity within given sectors, we define productivity in this study relative to the average productivity in the same sector-year. Hence, a value of 2 implies that a given firm is twice as productive as the average firm in that sector-year.

Figure 4 shows the distribution of firm productivity according to their internationalization status, both for manufacturing and services. The ranking of distributions for the case of Dutch firms is consistent with the findings in the literature; the distributions shift to the right (higher productivity) according to export status. More productive firms select into higher-cost market entry forms (see for instance Helpman, Melitz, and

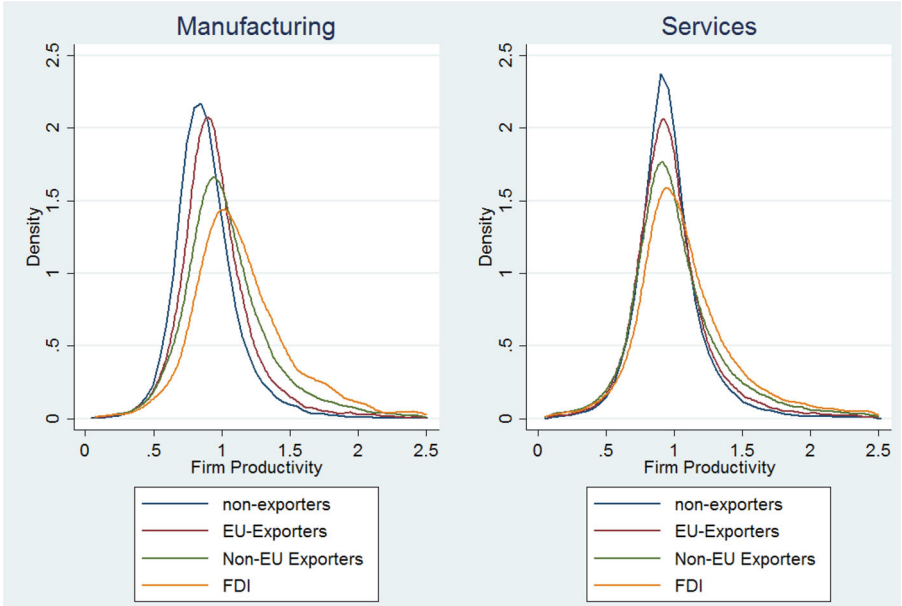

Figure 4. Productivity density distributions and export status.

Notes: in order to avoid sectoral differences in productivity from driving the results, productivity in this figure is defined relative to the average productivity in the same sector and year (hence, a value of 2 means that a given firms is twice as productive as the average firm in that sector-year.

Yeaple 2004). The shift is more pronounced for manufacturing (left panel) than for services (right panel). The distributions overlap more than in most other papers, which is perhaps not so surprising given the high degree of international participation of Dutch firms, indicating relatively low entrance costs to foreign markets (see Figure 2).

3.4. Firm-level variables

We broadly follow the empirical literature on firm heterogeneity and exports by employing as explanatory firm variables *total sales, worker skills* (measured as average wage per worker), *liquidity* (dummy = 1 if short term assets are larger than short term debts), firm age (dummy = 1 if firm is less than five years in existence),[19] *firm debt* (long term debt/total assets), *capital intensity* (proxied by a firm's material assets divided by the number of workers), *import status* (dummy equals 1 if the firm reports positive imports) and *foreign ownership* (dummy equals 1 if the firm is controlled by a foreign entity).[20] Firm productivity is the key variable in the Melitz (2003) model. Higher worker skills can be looked upon as increasing the export probability. With respect to capital intensity, we also want to establish if this has an impact on the likelihood of exporting. Since it is costly (and risky) to export we also want to control for the fact that the export status can depend on a firm's financial structure. The import status might matter because acquiring knowledge about foreign markets and doing business abroad is thought be easier ceteris paribus if a firm is an importer. Being an importer reduces the cost of accessing a foreign market (due to the knowledge gained) and thus increases export probability. In a similar vein, foreign ownership might be relevant for the export status in the sense that

Table 2. Descriptive statistics for explanatory variables.

Variable	No. of obs.	Mean	Sd.	p1	p99
TFP	271,217	1	0.36	0.38	2.3
Log sales	271,217	8.1	1.2	6	11
Log skills	271,217	3.9	0.38	3	4.9
Log capital intensity	271,217	2.8	1.7	−2.2	6
Firm debt	271,217	0.21	0.25	0	1
Firm dummies					
Liquidity	271,217	0.75	0.44	0	1
Firm age	271,217	0.10	0.30	0	1
Import status	271,217	0.58	0.49	0	1
Foreign owned	271,217	0.07	0.25	0	1
Internationalisation status					
Exports in general	271,217	0.51	0.50	0	1
Exports to EU	271,217	0.49	0.50	0	1
Exports to outside EU	271,217	0.26	0.44	0	1
FDI	271,217	0.04	0.21	0	1
Regional dummies and market access					
North	271,217	0.08	0.27	0	1
East	271,217	0.22	0.41	0	1
South	271,217	0.25	0.43	0	1
West	271,217	0.46	0.50	0	1

Notes: The table reports the summary statistics for the firm-years observed between 2010 and 2016 which confirm to the sample selection as outlined in Section 3.2. The variables are defined as outlined in Section 3.4. Due to the sensitive nature of the microdata, we are not allowed to report maxima or minima. Hence, 1st and 99th percentile values are displayed instead.

foreign-owned firms by definition have knowledge about foreign markets. In addition, we include firm *location* within the Netherlands (at NUTS1 level), as it is for instance well-known that location can be an important stimulus or barrier to trade. Location can for instance matter since it shapes a region's specialization structure and thereby impact its export potential or it could impact on a region's foreign market access (Brakman, Garretsen, and van Marrewijk 2009). Most firms are located in the West, and one could hypothesize that firms in larger or more densely populated regions would find it relatively easy to gain knowledge about foreign markets through more extensive networks. This reduces their market entry costs and therefore increases a firm's probability of exporting. The periphery is far less densely populated by the firms. For the Netherlands being a peripheral location implies a relatively large distance to the main international airport Schiphol (Amsterdam) or the port of Rotterdam. However, it also has off-setting effects in terms of market access, since part of the North, East and especially South, as opposed to the West, are close to the border with Belgium and/or Germany. Note, that Figure 3 already hints at the potential importance of firm location; a location in the North seems to contribute negatively to export status, whereas a location in the South seems to contributes positively. Finally, Table 2 provides the descriptive statistics for the explanatory variables; Table A2 provides the corresponding correlation matrix.

3.5. Methodology

As a first pass, we will present the results of a cross-section in which we regress the various firm variables on export status. Such model is given by equation (1) where $X_{i,t}$ is a dummy indicating if firm i is exporting at time t (dummy equals 1 if firm exports), $Y_{i,t}$ is

a set of firm-specific explanatory variables, and we include sector fixed effects δ_s as well as time fixed effects δ_t; $e_{i,t}$, is the error term.

$$P_r(Export\ status_{i,t} = 1|Productivity_{i,t}) = F(\beta' Y_{i,t} + \delta_s + \delta_t + e_{i,t}) \quad (1)$$

However, an estimation such as equation (1), although providing some useful insights on the dimensions in which exporters and non-exporters differ, might suffer from various forms of bias. For instance, existing exporters are likely to have larger sales due to their foreign sales, and might also find it easier to import due to their existing foreign connections. One solution would be to lag all the right-hand side variables by a year, but in practice this would change little due to the high persistence in exporting (90% of the firms who do not export in a given year also do not export next year, and 95% of the existing exporters continue to do so in the following year).

Therefore, to get a better insight into the factors that drive firms to start exporting, we base the main reports on the sample of non-exporters. In this case, we also allow for a two-year lag between observing the firm-level variables and the export status, conditional on not exporting in the first year. Hence, the main model will be based on equation (2), where the right-hand side variables are the same as above and $X_{i,t}$ is again indicating whether firm i is exporting at time t.

$$P_r(X_{i,t+2} = 1|X_{i,t=0}, Productivity_{i,t}) = F(\beta' Y_{i,t} + \delta_s + \delta_t + e_{i,t}) \quad (2)$$

Introducing a two-year lag between the observed variables and the change in export status has two benefits for the interpretation of results. First of all, it is likely that there will be a time lag between firms taking the decision to start exporting and actual exports taking place, as they need to set up a foreign sales network and may need some time to ensure that the product complies with foreign regulations. Secondly, a two-year lag reduces concerns over reverse causality, for instance in the case that exporting leads to higher productivity through learning by doing.[21] Hence, equation (2) will give a better insight into the factors that determine the export decisions for firms.

4. Estimation results

4.1. Exporters versus non-exporters

Table 3 shows the Probit results for equation (1), that is, exporters versus non-exporters. Columns (1) and (2) show the results for the manufacturing sector. Column (1) shows that firm productivity has a significant effect on the export probability, which is in line with prior research. As more control variables are added in column (2), a few observations stand out. First, the coefficient for productivity drops markedly once we include other explanatory variables. In particular the inclusion of firm size causes a very substantial part of the productivity effect to disappear. To some extent this might be unsurprising, as (export) productivity and size are correlated, according to the Melitz (2003) model.[22] Other firm-specific variables, such as import status and foreign ownership have a positive effect on export probability.[23] This suggests that earlier export experience and international contacts add to the probability of exporting, as these factors reduce market entry costs. With regards to location, firms in South which are close to foreign markets have a significantly higher export probability, whereas a location in the peripheral North or the densily populated West reduces the export probability.

Table 3. Exporters versus non-exporters, 2010–2016[a].

Variables	Manufacturing		Services	
TFP	0.956***	0.110*	0.446***	0.0607***
	(16.45)	(2.08)	(26.21)	(3.58)
Log sales		0.379***		0.201***
		(19.19)		(29.24)
Log skills		−0.000926		0.189***
		(−0.02)		(11.65)
Log capital intensity		0.0207*		0.0247***
		(2.01)		(6.17)
Firm debt		0.0661		0.0468*
		(1.24)		(1.98)
Liquidity		0.0429		0.0719***
		(1.51)		(6.00)
Young firm		−0.0948*		−0.0171
		(−2.11)		(−1.08)
Import status		1.139***		1.143***
		(36.79)		(95.89)
Foreign owned		0.291**		0.289***
		(3.11)		(9.12)
West		−0.171***		−0.0673***
		(−4.56)		(−4.20)
North		−0.245***		−0.248***
		(−4.48)		(−9.26)
South		0.196***		0.206***
		(4.81)		(11.47)
No. of obs.	45,282	45,282	225,874	225,874
R^2	0.12	0.30	0.21	0.35

Notes: Results based on probit model in equation (1) for the years 2010–2016. *T*-statistic reported in brackets. Sector-year dummies are included in all specifications (NACE 2-digit). NUTS1 region East is dropped as spatial dummy. Standard errors are clustered on a firm level. * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

[a]See Table A3 for a more detailed location analysis for individual provinces.

Columns (3) and (4) repeat the analyses for the *services* sector. Columns (3) and (4) show similar results for the services sector when analyzing productivity; firm productivity is important for the export status, but the size of the coefficient drops again markedly once the firm size is also controlled for. The other results in column (4) are different. For firms in the services sector not only foreign ownership, firm size and import status are important, as in the case of manufacturing firms, but also skill, capital intensity, firm debt and liquidity add to the explanation (see also Breinlich and Criscuolo 2011). This finding is consistent with WTO (2016), which finds that for the service industry finance related variables tend to be more important than for manufacturing, especially for smaller firms. The influence of location is largely similar though: a location in the South adds to the probability of exporting, whereas a location in the North or West has a negative impact. Furthermore, the results remain virtually unchanged when we add region-year dummies or when we change for a different TFP measure as Table A3 in the Appendix 3 shows.

Figure 5 illustrates that the models of Table 3 (column (2) for manufacturing, and column (4) for services) have a strong out-of-sample predictive power. The model has been calibrated for the period 2010–2012 and are subsequently applied to the observations in the years 2013–2016. Each dot in Figure 5 represents firms with the same

Figure 5. Out of sample predictive power: Panel A – Manufacturing, Panel B – services[a].

Notes: Model estimated based on columns (2) and (4) of Table 3 for the firms observed in the year 2010–2012 (excluding year dummies). The model is then applied to the firms observed in the years 2013–2016 to predict their export probability. The firms are grouped into bins based on their export probability, as displayed on the *x*-axis. The *y*-axis displays the actual percentage of firms in the bin that exports. [a]The coefficients from Table 3 (columns (2) and (4)) are used to estimate the export probability for firms in 2013–2016. In order to construct the figure above, we have calculated and plotted for each probability group (say all firms with a 50% chance of exporting according to the model) the percentage of firms that indeed exports.

export probability according to our model (rounded off to the nearest integer). As can be seen, the predicted values are extremely close to the actual probabilities that a given firm exports. For instance, for all the firms that our model predicted a 70% chance of exporting based on the model calibrated to the years 2010–2012 are grouped into a single bin, and approximately 70% of these firms indeed exports when applying the model to the 2013–2016 data. In both panels, the observations are close to the 45-degree line; the respective *R*-squares are 0.99 and 1.00. Hence, the model seems to capture some aspects of general relevance for the export behavior of firms.

4.2. The export status of high-productive firms

Given the main goal of our paper, the next and crucial step is to analyze the export decisions of firms that are *above* the productivity cut-off value. As we argued in Section 2, the cut-off value for productivity is a key factor to explain which firms do export in the Melitz (2003) related literature. The relationship between productivity and exporting is clearly present in our sample of firms as Figure 6 shows. Note, that although a clearly demarcated productivity cut-off value is not visible, the share of exporting firms in the combined sample gradually increases as productivity increases from 0.42 in the first decile to 0.62 in the last decile.[24]

Given our measure of productivity, we identify the decile in our distribution of productivity for which it holds that the majority of firms export. This decile defines the

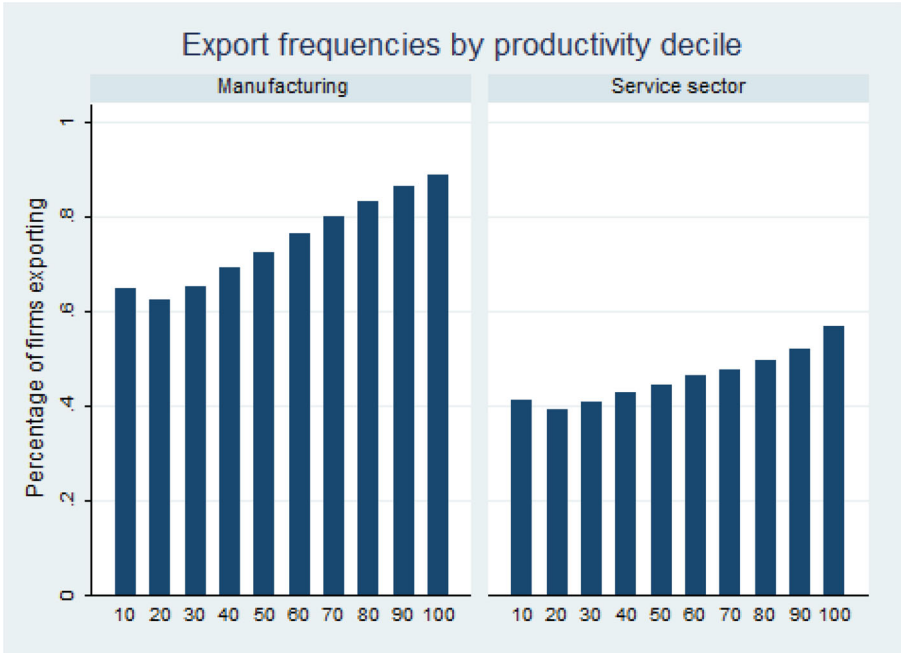

Figure 6. Share of exporting firms per productivity decile for manufacturing and services.

Notes: In order to prevent sectoral differences in productivity from driving the results, firms within each NACE 2-digit industry and year have been divided into productivity deciles. As a result, each decile shown in the figure has the identical NACE 2-digit industry-year composition.

cut-off. In our sample, we take the 7th productivity decile as the cut-off productivity level (which means that 30% of the firms in each NACE Rev.2 industry are more productive than the cut-off value), as more than 50% of all firms in this decile exports. This cut-off value of the 7th decile is similar to the cut-off used by Altomonte, Aquilante, and Ottaviano (2012).[25]

As can be seen in Figure 6, not all firms that meet the productivity cut-off do export. It is therefore important to investigate which factors determine the export status for firms above the productivity cut-off. Table 4 shows the results for our sample period 2010–2016, where columns (1) and (3) present the results for the firms below the productivity cut-off and columns (2) and (4) present the results for firms above the productivity cut-off. Can a high productivity compensate for some of the factors of importance in table (3)?

For manufacturing firms (compare columns (1) and (2) in Table 4), firm size, import status and location are important for both groups, whereas foreign ownership is less important for high-productive manufacturing firms. The results for the firm variables for the services sector are relatively similar between the groups above and below the productivity cut-off. A similar remark holds for the spatial dimension; the division between the Northern and the Southern part of the Netherlands is still visible in the data. It holds for low and medium productive services firms as well as for the most productive services firms. For high-productive services and manufacturing firms, a peripheral location in the North cannot be compensated by productivity.

Table 4. Exporting in manufacturing and services, conditional on meeting productivity cut-off, 2010–2016[a].

	Manufacturing		Services	
Variable	Low/medium productive	Highly productive	Low/medium productive	Highly productive
Log sales	0.381***	0.361***	0.204***	0.187***
	(17.93)	(11.04)	(26.47)	(17.12)
Log skills	0.0193	−0.0814	0.201***	0.171***
	(0.37)	(−1.00)	(10.77)	(6.67)
Log capital intensity	0.0094	0.0429*	0.0152**	0.0397***
	(0.80)	(2.57)	(3.23)	(6.46)
Firm debt	0.0766	0.0799	0.0376	0.107*
	(1.31)	(0.76)	(1.46)	(2.53)
Liquidity	0.0311	0.0749	0.0626***	0.110***
	(1.05)	(1.08)	(4.86)	(4.51)
Young firm	−0.0904	−0.116	−0.0200	−0.0123
	(−1.84)	(−1.31)	(−1.12)	(−0.45)
Import status	1.091***	1.312***	1.113***	1.215***
	(32.73)	(21.18)	(82.26)	(61.12)
Foreign owned	0.469***	0.117	0.388***	0.153**
	(4.37)	(0.96)	(10.39)	(3.27)
West	−0.178***	−0.149*	−0.0678***	−0.0683**
	(−4.31)	(−2.20)	(−3.76)	(−2.61)
North	−0.245***	−0.278**	−0.214***	−0.338***
	(−4.11)	(−2.83)	(−7.16)	(−7.55)
South	0.217***	0.129	0.222***	0.170***
	(4.88)	(1.70)	(11.05)	(5.66)
No. of obs.	31,613	13,225	158,119	67,755
R^2	0.29	0.29	0.34	0.38

Notes: Results based on probit model in the form of equation (1) for the years 2010–2016.The sample is split by productivity, with the 30% most productive firms in each industry-year included in the high-productive sample. Sector-year dummies are included in all specifications (NACE 2-digit). NUTS1 region East is dropped as spatial dummy. Standard errors are clustered on a firm level. The *t*-statistics are reported in brackets. A joint test rejects the equality of the coefficients between columns (1) and (2) as well as columns (3) and (4). * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

[a]See Appendix 2 for some sensitivity analyses with respect to the productivity cut-off value; the results, in a qualitative sense, are robust.

4.3. Export dynamics

The results of the previous two sections are based on a comparison of existing exporters with non-exporters. As exporting itself may also affect firm variables (for instance, due to learning by doing), the results may not be fully indicative of the factors that hold highly productive non-exporting firms back from successfully exporting. Hence, this section instead focusses on high-productive firms that do not export initially, and analyze which factors influence the decision to start exporting within the next two years. Figure 7 shows the productivity distributions for non-exporters and firms that start exporting for the first time within the next two years, both for manufacturing firms (left panel) and service firms (right panel). Although the firms that start exporting are somewhat more productive than non-exporters, the difference appears rather small, especially when compared to Figure 6.

Table 5 displays the results of equation (2), conditional on the productivity cut-off. The results confirm some of the earlier findings, namely that firm size and import status are important in order to become an exporter for all firms, and so are foreign ownership and skill for the services sector. Location is especially important for the services sector,

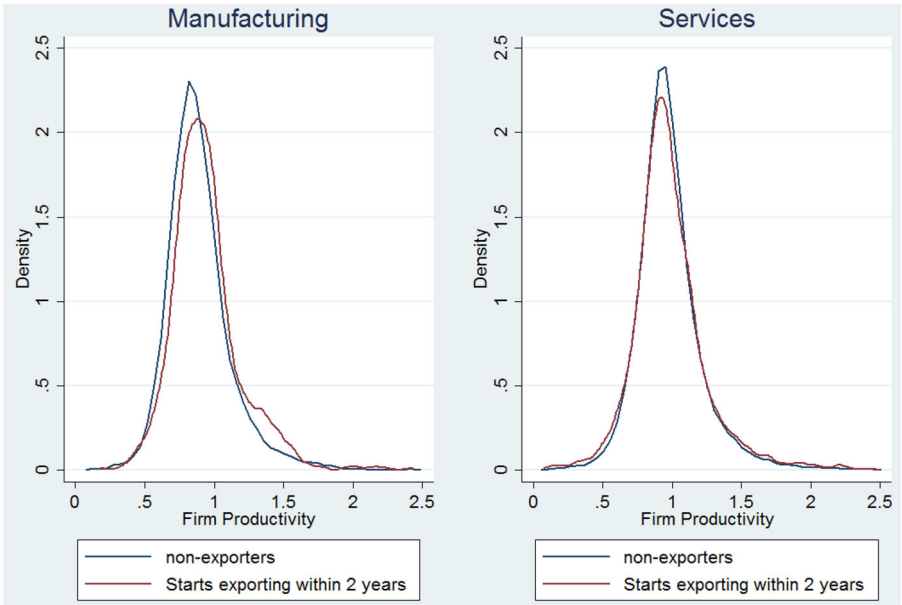

Figure 7. Productivity density between non-exporters that remain non-exporters and those that are exporters two years later.

Note: In order to avoid sectoral differences in productivity from driving the results, productivity in this figure is defined as (firm productivity/average productivity of all firms in the same year in the same NACE2-sector).

whereas it seems to play a smaller role for the manufacturing sector. The difference in the factors relevant to exporting between low/medium productive and high-productive firms appears to be rather small. Furthermore, in order to *become* an exporter, the contribution of productivity as such is limited, which seems to be largely driven by the correlation between firm size and productivity (see Table A6 in the appendix that provides information unconditional on productivity). In the case of the decision to start exporting, firm productivity does not have an effect once firm size is controlled for. Furthermore, Finally, Appendix 4 provides an out-of-sample test based of the model, in which it again seems performs quite well.

One might be concerned that the location variables reflect partially anticipation effects, as firms might move in anticipation of exporting to regions close to the border. However, the limited spatial mobility of Dutch firms makes this unlikely. Statistics Netherlands (Pouwels-Urlings and Wijnen 2013) finds that only 2% of the Dutch firms change their municipality in a given year, and out of these firms, only 5% moves further than 75 km from their original location. Hence, spatial sorting does not seem to be a major issue in the Dutch context. Furthermore, the results remain virtually unchanged when we add region-year dummies to control for regional shocks (see Table A7 in the appendix).

4.4. Exporting to non-EU countries

Finally, we can also investigate the factors that contribute to firms starting to *non*-EU countries. In the Melitz (2003) type of analyses, exports to the non-EU might be only

Table 5. Dynamic export analysis, conditional on productivity.

	Manufacturing firms		Service firms	
Variable	Low/medium productive	Highly productive	Low/medium productive	Highly productive
Log sales	0.248***	0.195*	0.108***	0.101***
	(5.69)	(2.58)	(7.79)	(5.58)
Log skills	−0.0957	−0.171*	0.113***	0.103*
	(−0.80)	(−0.94)	(3.32)	(2.25)
Log capital intensity	0.0440	−0.0566	−0.0013	0.0302**
	(1.67)	(−1.47)	(−0.15)	(2.86)
Firm debt	0.0842	0.506*	0.0654	−0.0680
	(0.67)	(2.00)	(1.47)	(−0.89)
Liquidity	0.112	−0.128	−0.00413	−0.0242
	(1.69)	(−0.71)	(−0.18)	(−0.54)
Young firm	0.228*	0.217	0.118***	0.196***
	(2.49)	(0.99)	(4.00)	(4.10)
Import status	0.345***	0.501***	0.378***	0.382***
	(5.31)	(3.65)	(14.65)	(10.09)
Foreign owned	0.006	0.114	0.318***	0.199*
	(0.01)	(0.39)	(3.99)	(2.18)
West	−0.147	0.142	−0.0098	−0.0728
	(−1.80)	(0.82)	(−0.33)	(−1.61)
North	−0.175	0.172	−0.0868	−0.262***
	(−1.62)	(0.69)	(−1.84)	(−3.42)
South	0.0906	0.178	0.178***	0.0910
	(0.97)	(0.93)	(5.16)	(1.67)
No. of obs.	4756	962	47,971	20,495
R^2	0.11	0.11	0.11	0.13

Notes: Results based on probit model in the form of equation (2) for the years 2010–2016.The sample is split by productivity, with the 30% most productive firms in each industry-year included in the high-productive sample. NUTS1 region East is dropped as spatial dummy. Sector-year dummies are included in all specifications (NACE 2-digit). Standard errors are clustered on a firm level. The *t*-statistics are reported in brackets. High-productive firms form slightly less than 30% of the observations, due to the fact that we only include non-exporters. A joint test rejects the equality of the coefficients between columns (1) and (2) as well as columns (3) and (4). * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

possible for the most productive firms, as entering and exporting to more distant markets is more expensive and complex than exporting to EU markets. Table 6 shows which determinants affect the probability that firms which do not yet export to outside the EU, start doing so within the next two years.

The results differ markedly from earlier analyses for the spatial dummies. First of all, for low and medium productive firms, a location in the densely populated urban regions of the West (which includes the major port of Rotterdam and Amsterdam airport) now increases the probability that a firm starts exporting outside of the EU. The location in the South of the Netherlands, which in the previous analyses appeared very conducive to exporting, no longer has a positive effect. Even though the export intensity in general is highest in the South (see Figure 3), it appears that firms encounter difficulties in taking the next step to sell their goods or services also outside of the EU. This finding is consistent with the findings of the WTO (2016) for small and medium size firms; these are most affected by a lack of access to good transport facilities and insufficient information about distant markets, as is most likely the case in peripheral locations. With regards to the other variables, Table 6 again highlights the importance of size and import status as key determinants of future exports. Furthermore, firms that already export to

Table 6. Decision to start exporting outside of EU, conditional on productivity.

	Manufacturing		Services	
Variables	Low/medium productive	Highly productive	Low/medium productive	Highly productive
Firm exports to EU	0.0641***	0.0879***	0.0544***	0.0664***
	(10.12)	(6.33)	(18.42)	(14.71)
Log sales	0.0231***	0.0313***	0.00659***	0.00447**
	(5.08)	(3.48)	(5.58)	(2.99)
Log skills	0.0104	−0.0433*	0.000755	0.00716
	(0.90)	(−2.17)	(0.27)	(1.83)
Log capital intensity	−0.00258	0.000640	0.000278	0.000607
	(−1.14)	(0.17)	(0.43)	(0.72)
Firm debt	0.0140	0.0597	0.000646	0.00273
	(1.29)	(1.83)	(0.19)	(0.47)
Liquidity	0.0124*	0.00419	0.000555	−0.000642
	(2.22)	(0.22)	(0.33)	(−0.18)
Young firm	0.0129	−0.0250	0.0120***	0.00888
	(1.33)	(−1.24)	(4.58)	(1.95)
Import status	0.0165**	0.0113	0.0127***	0.0190***
	(2.96)	(0.78)	(6.41)	(6.09)
Foreign owned	0.0464	0.00447	0.0143	0.0126
	(1.20)	(0.12)	(1.64)	(1.18)
West	0.0146*	0.0230	0.00595**	0.00417
	(1.96)	(1.26)	(2.74)	(1.11)
North	0.00624	−0.0183	−0.00422	−0.0105*
	(0.63)	(−0.79)	(−1.45)	(−2.17)
South	0.00132	−0.0209	−0.00273	−0.00365
	(0.17)	(−1.14)	(−1.10)	(−0.84)
No. of obs.	10,368	2999	69,135	31,059
R^2	0.130	0.099	0.144	0.146

Notes: Results based on probit model in the form of equation (2) for the years 2010–2016.The sample is split by productivity, with the 30% most productive firms in each industry-year included in the high-productive sample. NUTS1 region East is dropped as spatial dummy. Sector-year dummies are included in all specifications (NACE 2-digit). Standard errors are clustered on a firm level. The *t*-statistics are reported in brackets. High-productive firms form slightly less than 30% of the observations, due to the fact that we only include non-exporters. A joint test rejects the equality of the coefficients between columns (1) and (2) as well as columns (3) and (4). * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

EU-countries are far more likely to start exporting to outside Europe, which is in line with the predictions of the Melitz model.

4.5. Location

The results in the preceding sections already highlight the importance of location. Firms located in the North appear to face stronger export barriers than those located in the South or West, but it is unclear whether and how location factors do indeed contribute to this outcome. To get some grasp at the role of location in determining the export chances of Dutch firms, we replaced the location dummies in Table 3[26] with specific location variables: distance to the foreign border (in kilometers), road density (on NUTS3 level, as a location-specific measure of transport cost), distance to the main international airport (in kilometers),[27] a specialization index (number of firms in own sector as a ratio of all firms in the same NUTS3 region; measuring location-specific externalities), density of exporters (number of exporting firms in own industry/km^2 in the same NUTS3 region;

Table 7. Descriptive statistics for regional variables.

Variable	No. of obs.	Mean	Sd.	p1	p99
Distance to border	245,971	46	32	1.3	121
Highway density	245,971	0.21	0.10	0.04	0.45
Distance to Schiphol	245,971	75	45	4.8	180
Market access Germany	245,971	6.0	5.5	0	14
Market access Belgium	245,971	6.1	5.5	0	14
Regional specialization	245,971	0.08	0.07	0.002	0.25
Density of exporters in same industry	245,971	0.10	0.17	0	0.85
Firm density	245,971	2.3	1.6	0.32	5.9

Note: Summary statistics based on full sample of firms observed between 2010 and 2016.

a large density could facilitate export market knowledge spill-overs) and the general density of firms (in the same NUTS3 region; knowledge spill-overs in general).[28]

Furthermore, we add a market access variable to the Belgium and German market. Foreign market access is potentially important for firms in the Netherlands when it comes to serving or doing business on a foreign market as large parts are thus quite close (in actual travel time) to the German or Belgian border. Appendix 2 shows market access of locations in the Netherlands to the Belgium and German markets. We measure market access in terms of the number of foreign jobs that are within 90 km radius of a municipality (a simple distance decay function is applied). Table 7 provides the descriptive statistics of the regional variables.

Table 8 presents the results of equation (1) when including the specific regional factors. A few observations stand out. First, the firm-level coefficients are robust for changes in location-specific variables. This holds both for manufacturing and services. Second, the distance to the border is important – the closer the better – and also a higher export firm density increases the likelihood of exporting. The latter suggests that being part of a network of exporters helps to access a foreign market; export market knowledge spill-overs seem important. In addition, market access to Belgium is important for all firms, whereas the German market access appears to be less important. In this respect it is noteworthy that large and densely populated areas in Belgium are very close to the Dutch border (Liege, Antwerp), but this is less the case for Germany where in particular the part of Germany that borders the North of the Netherlands is sparsely populated and peripheral within Germany. For the service sector, the density of firms and regional specialization is also important. These variables also point towards the importance of networks; both being close to own-sector/industry firms and firms in general are important. Together the location variables point towards the importance of local knowledge spill-overs that help to reduce entry barriers of foreign markets.

5. Discussion and conclusion

According to the seminal contribution by Melitz (2003), exporting firms have to be productive enough to overcome the higher entry costs of foreign markets. The Melitz (2003) framework concludes that once firms are productive enough to overcome the higher entry costs of foreign markets they *all* export. However, we know from earlier empirical research that the productivity distributions of exporters and domestic firms overlap, high-productive firms do not export, and some low-productive firms are able to export. Our analysis helps to identify systematically to identify other factors

Table 8. Influence of regional factors on probability of being an exporter.

	Manufacturing firms		Service firms	
Variable	Low/medium productive	Highly productive	Low/medium productive	Highly productive
Log sales	0.395***	0.394***	0.208***	0.208***
	(21.71)	(21.62)	(31.48)	(31.50)
Log skills	−0.00402	−0.0114	0.192***	0.192***
	(−0.08)	(−0.24)	(11.53)	(11.51)
Log capital intensity	0.0221*	0.0244*	0.0261***	0.0276***
	(2.08)	(2.29)	(6.41)	(6.75)
Firm debt	0.0649	0.0792	0.0350	0.0401
	(1.19)	(1.46)	(1.47)	(1.68)
Liquidity	0.0513	0.0483	0.0826***	0.0801***
	(1.80)	(1.69)	(6.78)	(6.58)
Young firm	−0.0977*	−0.0989*	−0.0145	−0.0123
	(−2.13)	(−2.18)	(−0.89)	(−0.76)
Import status	1.146***	1.144***	1.150***	1.154***
	(36.30)	(36.18)	(94.18)	(94.67)
Foreign owned	0.283**	0.277**	0.293***	0.296***
	(2.99)	(2.93)	(9.16)	(9.22)
West	−0.173***		−0.0653***	
	(−4.52)		(−4.02)	
North	−0.244***		−0.256***	
	(−4.35)		(−9.28)	
South	0.197***		0.208***	
	(4.78)		(11.45)	
Distance to border		−0.00322***		−0.00384***
		(−3.43)		(−8.91)
Highway density		−0.436		−0.266*
		(−1.45)		(−2.25)
Distance to Schiphol		−0.000589		0.000414
		(−0.86)		(1.48)
Market access Germany		0.00597		−0.00221
		(1.26)		(−1.14)
Market access Belgium		0.0112**		0.00686***
		(2.94)		(4.31)
Regional specialization		1.955		1.432***
		(0.98)		(4.50)
Exporter density		2.643*		0.195*
		(2.17)		(2.56)
Firm density		0.00592		0.0382***
		(0.25)		(4.35)
No. of obs.	41,086	41,086	204,885	204,885
R^2	0.30	0.31	0.35	0.35

Notes: Results based on probit model in the form of equation (1). Sector-year dummies are included in all specifications (NACE 2-digit). NUTS1 region East is dropped as spatial dummy. Standard errors are clustered on a firm level. * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

which prevents these high-potential non-exporters from reaching foreign markets. The following findings stand out.

First of all, productivity is a necessary, but not a sufficient condition for exporting. Other firm characteristics determine or add to the export probability; for the manufacturing firm size, sector import status and foreign ownership are the most important determinants of export behavior, whereas for firms in the service sectors additional factors are also relevant, such as worker skills, liquidity, capital intensity and foreign ownership which add to increase export probability. Given that most firms are in the services

sector and even the median exporter is a service firm, the current neglect of the service sector in research appears unwarranted. Existing exporters are in general slightly more productive then non-exporters, but such difference is not visible for firms when they start exporting. These findings stand in contrast with most of the literature, and suggest that learning by doing or scale benefits of exporting are an important reason why exporters are more productive than non-exporters, rather than selection effects. This difference might well be due to the fact that most of the literature only employs data on large manufacturing firms, whereas we have nearly exhaustive data on all firms. Alternatively, the openness of the Dutch economy combined with the high-quality international infrastructure might reduce the fixed costs of exporting (reflected by the fact that 49% of the firms in our sample exports), which diminishes the necessity of productivity for profitable exporting.

Second, firm location is crucial. A location in more peripheral areas goes along with a lower export probability for even high-productive firms; especially for firms located in the North of the Netherlands. Some location factors stand out. The distance to the border is important – the closer the better – as well as the local export firm density. The latter suggests that being part of an export network helps firms to access a foreign market; export market knowledge is important as it reduces market entry costs. In addition, for services market access in the South (Belgium), specialization and firm density affect exports positively. Also these variables point towards the importance of networks.

Third, our analysis highlights that we can predict to some degree which firms are likely future exports and which ones not. However, substantial unexplained heterogeneity remains, which opens the question which other factors prevent some firms from exporting whom appear to have all the relevant characteristics. Future research would do well to investigate this subgroup of potentially exporters more closely and focus thereby on possible informational, organizational or managerial barriers to trade (see also Bloom et al. [2018] for evidence how the probability to trade for firms is related to management quality of firms for a large sample of US and Chinese firms). Lowering this kind of trade barriers would enable these firms to expand their sales by entering foreign markets which could also allowing the already highly productive firms to grow further.

Notes

1. See Melitz and Redding (2014) for an excellent review of the theory and Bernard et al. (2012) for empirical results.
2. What happens inside exporting firms compared to non-exporting firms is the topic of recent research. Caliendo, Monte, and Rossi-Hansberg (2017) point out, for a sample of French firms, that the higher wages in the export sector could be caused by a composition effect; exporters add an additional (high wage) management layer to the firm compared to non-exporters. Wages in the pre-existing (management) layers go down.
3. Especially the split of non-exporters versus exporters deserves further attention and needs an explanation as this distinguishes structural trade models from a balls-and-bins model of trade, as is pointed out by Armenter and Koren (2014, 2129). We focus on this split but conditional on productivity levels (high and low).
4. This line of reasoning resulted in a new derivation of the gravity model (Chaney 2008).
5. For similar graphs, see, for instance, Berg van den and van Marrewijk (2017); Melitz and Trefler (2012); Altomonte, Aquilante, and Ottaviano (2012); Mayer and Ottaviano (2007).
6. Or to be more specific, the majority of the public and limited liability companies, as very small owner-operated firms are often not a separate legal entity and thus do not have to file a corporate income tax declaration.

7. The matching rate between the three data sources are relatively high, as the General Business Register (GBR) and VAT-register in principle cover the universe of firms. The financial information is taken from the firm corporate tax registry, which is also the smallest of the three databases as it does not include self-employed. The common identifier used is the firm's registration number at the Chamber of Commerce. The matching rate between the data from the corporate tax registry and the GBR is 98%. Conditional on this match being successful, the match rate between corporate tax registry and the VAT-register is 96%.
8. The resulting data-loss is limited. The VAT declarations from which the export status is taken are only available from 2008 onwards, and covers substantially fewer firms in 2008 and 2009 compared to the later years.
9. In order to correctly measure firm productivity using the Levinsohn and Petrin (2003) method, we also exclude firms which appear only once in the data and firms with incomplete spells. Furthermore, we also drop firms whose average wage per employee is above 500k a year or below 15k a year (which is significantly below the minimum wage).
10. We use 700 firm-years as (thus 100 firm observations on average per year) as the lower value for the NACE Rev.2 2-digit sectors. Most sectors are well above this minimum and the loss entails fewer than 1% of observations.
11. We thus exclude firms in the sectors NACE Rev.2 sectors D, E and O–U.
12. To be precise, 1,071,558 out of the 1,221,938 lost firm-years is due to the requirement of having at least 5 employees.
13. For brevity, we only include the number of observations for NACE Rev.2 section. For a more detailed breakdown by 2-digit classification, see Appendix 1.
14. *North* consist of the following provinces: Drenthe, Groningen, Friesland; *West*: Zuid Holland, Noord Holland, Utrecht; *East*: Gelderland, Flevoland, Overijssel; *South*: Zeeland, Limburg, Noord-Brabant (note that we include Zeeland in the South and not in West as in NUTS1). We have also experimented with using NUTS2 regions. However, the coefficients of the various NUTS2 regions within the same NUTS1 region were very similar, thus adding little to our analysis. Furthermore, in Section 5 we use much more detailed data on the Dutch municipality level to test which factors drive the regional differences.
15. A similar conclusion holds if we compare the share of highly productive firms (defined as firms which are in the top 30% of productive firms in their industry-year, see Section 4.2) across regions.
16. In other words, all sectors listed in Table 1 apart from "Manufacturing" and "Accommodation and food services" are grouped in the services sector. The manufacturing sector is simply the NACE Rev.1 sector "Manufacturing". We exclude "Accommodation and food services" in the remainder of this paper due to the extremely low export-intensity (less than 3% of the firms exports).
17. Alternatively, we could also have used the Unit Labor Costs (ULC), value added per worker, or the Ackerberg, Caves, and Frazer (2015) TFP method, as used recently by for instance Brandt et al. (2017) and Khanna and Sharma (2018). The correlations between the LP measure of TFP and the alternative measures are fairly high (0.89 in the case of the Ackerberg et al. TFP measure, 0.88 in the case of ULC). The correlation value added per worker is smaller (0.67), most likely because the latter measure does not correct for differences in worker skills.
18. As is common in the literature, we estimate the productivity by sector (NACE-2 classification).
19. The reason for the dummy is that the firm register of Statistics Netherlands starts in 2005, and hence we are uncertain of the age of firms which already existed in 2005.
20. Note that in the Melitz (2003) model there is a one-to-one correspondence between firm productivity and firm sales.
21. The reason for a two-year lag rather than a one year lag is that the firm-level variables are typically reported at the end of the year. Hence, to ensure that there is at least a full year between observing the firm-level variables and the export decision, we use the two-year lag.
22. Although in practice the correlation is far from perfect. In our sample, the correlation is 0.39 (see Table A2).
23. Kasahara and Lapham (2013) document potential gains from import and export complementarities implying that firms that do not export, but do import could potentially gain from becoming exporters (and vice versa).
24. See Table A1 and Figures A1 and A2 for a disaggregation into the NACE Rev.2 1-digit industries.
25. Exploratory sensitivity analyses indicate that our results are robust with respect to this choice of the 7th decile as cut-off; see also Table A4 and A5.

26. We prefer to use Table 3 for this analyses, as we have a far larger sample of firms to work with. As Section 4.3 indicated, spatial sorting for existing firms is unlikely to play a large role in the Netherlands.
27. The correlation of distance to the international airport of Amsterdam and distance to the port of Rotterdam is high (0.8). Therefore, only the distance to the International Airport of Amsterdam is included in the analysis.
28. These variables are well-known in empirical research in spatial economics, see f.i. Brakman, Garretsen, and van Marrewijk (2009) for a survey.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendices

Appendix 1. Descriptive statistics

Table A1. Number of observations per NACE Rev.2 2-digit sector.

Nace Rev.2 2-digit code	and name	No. of obs.	Percentage	Cumulative
10	Manufacture of food products	5086	1.76	1.76
13	Manufacture of textiles	1000	0.35	2.11
16	Manufacture of wood and of products of wood and cork	1692	0.59	2.69
17	Manufacture of paper and paper products	812	0.28	2.97
18	Printing and reproduction of recorded media	3389	1.17	4.14
20	Manufacture of chemicals and chemical products	1356	0.47	4.61
22	Manufacture of rubber and plastic products	2296	0.79	5.41
23	Manufacture of other non-metallic mineral products	1406	0.49	5.89
25	Manufacture of fabricated metal products, except machinery and equipment	10,900	3.77	9.67
26	Manufacture of computer, electronic and optical products	1584	0.55	10.21
27	Manufacture of electrical equipment	1373	0.48	10.69
28	Manufacture of machinery and equipment	5567	1.93	12.62
29	Manufacture of motor vehicles, trailers and semi-trailers	1017	0.35	12.97
30	Manufacture of other transport equipment	841	0.29	13.26
31	Manufacture of furniture	2417	0.84	14.09
32	Other manufacturing	1362	0.47	14.57
33	Repair and installation of machinery and equipment	3245	1.12	15.69
41	Construction of buildings	10,806	3.74	19.43
42	Civil engineering	2951	1.02	20.45
43	Specialised construction activities	24,298	8.41	28.86
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	14,115	4.88	33.74
46	Wholesale trade, except of motor vehicles and motorcycles	51,014	17.65	51.39
47	Retail trade, except of motor vehicles and motorcycles	27,991	9.68	61.07
49	Land transport and transport via pipelines	12,600	4.36	65.43
50	Water transport	1118	0.39	65.82
52	Warehousing and support activities for transportation	4372	1.51	67.33
53	Postal and courier activities	791	0.27	67.61
55	Accommodation	3867	1.34	68.95
56	Food and beverage service activities	13,937	4.82	73.77
58	Publishing activities	1366	0.47	74.24
59	Motion picture, video and television program production	1025	0.35	74.59
62	Computer programming, consultancy and related activities	13,506	4.67	79.27
63	Information service activities	1474	0.51	79.78
69	Legal and accounting activities	8779	3.04	82.82
70	Activities of head offices; management consultancy activities	8440	2.92	85.74
71	Architectural and engineering activities; technical testing and analysis	10,734	3.71	89.45
72	Scientific research and development	1201	0.42	89.86
73	Advertising and market research	5879	2.03	91.9
74	Other professional, scientific and technical activities	2277	0.79	92.69
77	Rental and leasing activities	2228	0.77	93.46
78	Employment activities	8502	2.94	96.4
79	Travel agency, tour operator and other reservation service and related activities	1137	0.39	96.79
80	Security and investigation activities	1077	0.37	97.17
81	Services to buildings and landscape activities	6420	2.22	99.39
82	Office administrative, office support and other business support activities	1773	0.61	100
	Total	289,020	100.00	100.00

Figure A1. Share of exporting firms per productivity decile, various sectors.

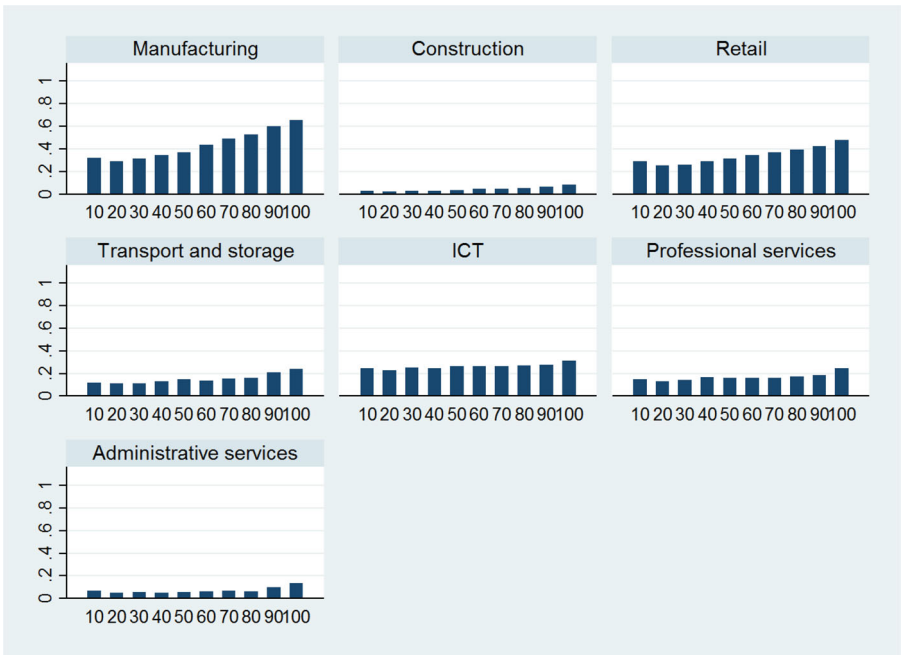


Figure A2. Share of non- EU exporting firms per productivity decile, various sectors.

Table A2. Correlation matrix of key variables.

	Exports in general	Exports to outside EU	Imports	FDI	TFP	Log sales	Log skills	Log capital intensity	Firm debt	Liquidity	Young firm	Foreign owned	North	East	South	West
Exports in general	1.00															
Exports to outside EU	0.59	1.00														
Imports	0.52	0.39	1.00													
FDI	0.17	0.19	0.13	1.00												
TFP	0.10	0.12	0.08	0.09	1.00											
Log sales	0.32	0.32	0.32	0.23	0.39	1.00										
Log skills	0.18	0.14	0.08	0.10	0.12	0.26	1.00									
Log capital intensity	0.12	0.10	0.17	0.04	0.04	0.20	0.07	1.00								
Firm debt	−0.02	−0.02	0.00	−0.02	−0.13	−0.03	−0.12	0.27	1.00							
Liquidity	0.10	0.10	0.10	0.02	0.19	0.12	0.11	−0.05	−0.16	1.00						
Young firm	−0.07	−0.07	−0.09	−0.05	−0.02	−0.14	−0.06	−0.17	0.00	−0.03	1.00					
Foreign owned	0.19	0.18	0.17	0.08	0.11	0.27	0.19	−0.07	−0.10	0.04	0.01	1.00				
North	−0.06	−0.05	−0.04	−0.02	−0.02	−0.02	−0.06	0.05	0.04	0.00	0.01	−0.04	1.00			
East	0.01	0.01	0.02	0.00	−0.01	0.01	−0.04	0.06	0.05	0.00	−0.01	−0.03	−0.15	1.00		
South	0.10	0.02	0.11	0.02	0.00	0.01	−0.03	0.03	0.01	−0.01	−0.01	0.00	−0.17	−0.30	1.00	
West	−0.07	0.00	−0.10	0.00	0.02	0.00	0.09	−0.10	−0.07	0.01	0.01	0.04	−0.26	−0.48	−0.53	1.00

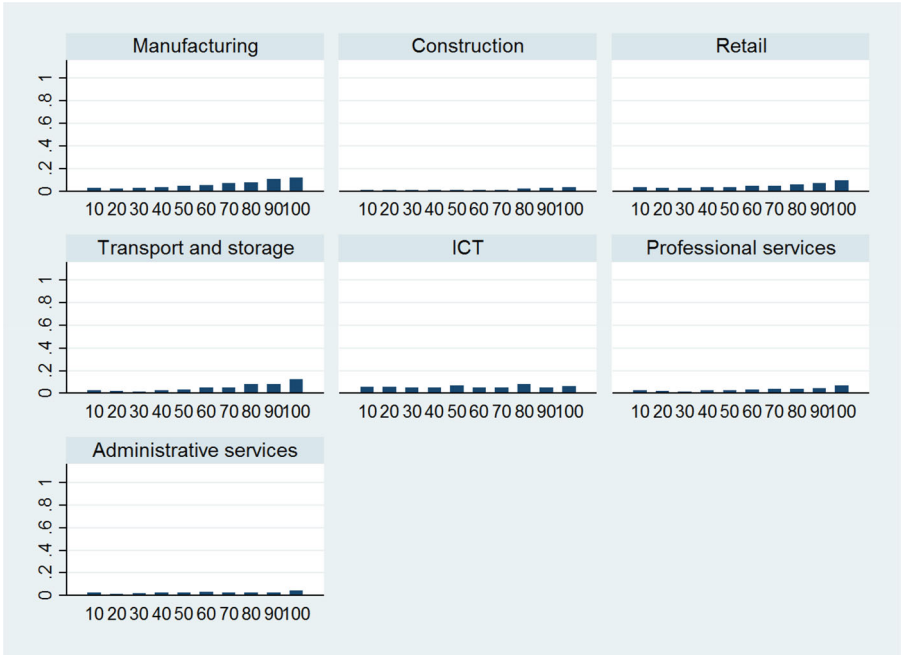
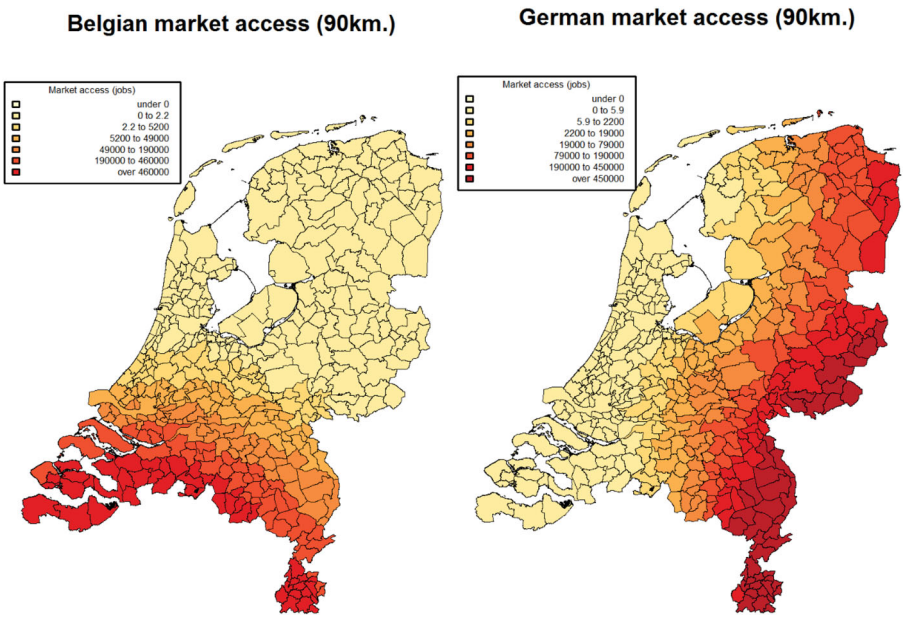


Figure A3. Share of firms per decile that engage in FDI, various sectors.

Appendix 2. Foreign market access



Appendix 3. Sensitivity analyses

Table A3. Cross-section with region-fixed effects and with Ackerberg, Caves, and Frazer (2015) TFP.

Variable	Manufacturing			Services		
TFP	0.110*	0.110*	0.123*	0.0607***	0.0607***	0.0612***
	(2.08)	(2.08)	(2.54)	(3.58)	(3.58)	(4.25)
Log sales	0.379***	0.380***	0.386***	0.201***	0.201***	0.205***
	(19.19)	(19.19)	(21.02)	(29.24)	(29.24)	(31.38)
Log skills	−0.000926	−0.00116	0.00302	0.189***	0.189***	0.192***
	(−0.02)	(−0.03)	(0.06)	(11.65)	(11.65)	(11.80)
Log capital intensity	0.0207*	0.0207*	0.0211*	0.0247***	0.0247***	0.0237***
	(2.01)	(2.00)	(2.04)	(6.17)	(6.17)	(5.89)
Firm debt	0.0661	0.0666	0.0710	0.0468*	0.0469*	0.0481*
	(1.24)	(1.24)	(1.33)	(1.98)	(1.99)	(2.04)
Liquidity	0.0429	0.0427	0.0395	0.0719***	0.0720***	0.0712***
	(1.51)	(1.50)	(1.39)	(6.00)	(6.00)	(5.94)
Young firm	−0.0948*	−0.0957*	−0.0967*	−0.0171	−0.0170	−0.0184
	(−2.11)	(−2.12)	(−2.15)	(−1.08)	(−1.07)	(−1.16)
Import status	1.139***	1.139***	1.139***	1.143***	1.143***	1.142***
	(36.79)	(36.79)	(36.78)	(95.89)	(95.88)	(95.87)
Foreign owned	0.291**	0.290**	0.291**	0.289***	0.289***	0.286***
	(3.11)	(3.10)	(3.11)	(9.12)	(9.12)	(9.03)
West	−0.171***		−0.171***	−0.0673***		−0.0675***
	(−4.56)		(−4.54)	(−4.20)		(−4.22)
North	−0.245***		−0.244***	−0.248***		−0.248***
	(−4.48)		(−4.46)	(−9.26)		(−9.25)
South	0.196***		0.196***	0.206***		0.206***
	(4.81)		(4.80)	(11.47)		(11.47)
Region-year fixed effects	No	Yes	No	No	Yes	No
TFP measure	Levinsohn and Petrin (2003)	Levinsohn and Petrin (2003)	Ackerberg, Caves, and Frazer (2015)	Levinsohn and Petrin (2003)	Levinsohn and Petrin (2003)	Ackerberg, Caves, and Frazer (2015)
No. of obs.	45,282	45,282	45,282	225,874	225,874	225,874
R^2	0.30	0.30	0.30	0.35	0.35	0.35

Notes: Results based on probit model in equation (1) for the years 2010–2016. *T*-statistic reported in brackets. Sector-year dummies are included in all specifications (NACE 2-digit). NUTS1 region East is dropped as spatial dummy. Standard errors are clustered on a firm level. * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

Table A4. Cross-section. Cut-off at 6th percentile (50% of firms above).

	Manufacturing firms		Service firms	
Variable	Low/medium productive	Highly productive	Low/medium productive	Highly productive
Log sales	0.367***	0.370***	0.211***	0.190***
	(15.21)	(14.54)	(23.34)	(21.70)
Log skills	−0.00927	−0.0294	0.203***	0.177***
	(−0.16)	(−0.47)	(9.62)	(8.41)
Log capital intensity	0.00733	0.0366**	0.00751	0.0384***
	(0.55)	(2.72)	(1.41)	(7.53)
Firm debt	0.0490	0.103	0.0193	0.0966**
	(0.77)	(1.32)	(0.69)	(2.87)
Liquidity	0.0393	0.00642	0.0551***	0.0976***
	(1.23)	(0.14)	(3.91)	(5.36)
Young firm	−0.0752	−0.123	−0.0199	−0.0162
	(−1.42)	(−1.82)	(−0.99)	(−0.75)
Import status	1.072***	1.237***	1.101***	1.182***
	(29.54)	(26.97)	(71.88)	(75.27)
Foreign owned	0.567***	0.186	0.420***	0.216***
	(4.70)	(1.72)	(9.91)	(5.46)
West	−0.151***	−0.194***	−0.0593**	−0.0754***
	(−3.32)	(−3.77)	(−2.94)	(−3.60)
North	−0.254***	−0.253***	−0.208***	−0.294***
	(−3.84)	(−3.31)	(−6.19)	(−8.26)
South	0.233***	0.155**	0.231***	0.182***
	(4.79)	(2.69)	(10.36)	(7.70)
No. of obs.	22,550	22,484	112,890	112,984
R^2	0.283	0.285	0.328	0.370

Notes: Results based on probit model in the form of equation (1) for the years 2010–2016.The sample is split by productivity, with the 50% most productive firms in each industry-year included in the high-productive sample. Sector-year dummies are included in all specifications (NACE 2-digit). NUTS1 region East is dropped as spatial dummy. Standard errors are clustered on a firm level. A joint test rejects the equality of the coefficients between columns (1) and (2) as well as columns (3) and (4). * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

Table A5. Cross-section. Cut-off at 90th percentile (10% of firms above).

	Manufacturing firms		Service firms	
Variable	Low/medium productive	Highly productive	Low/medium productive	Highly productive
Log sales	0.395***	0.356***	0.208***	0.152***
	(20.95)	(6.70)	(30.82)	(8.06)
Log skills	0.00377	−0.148	0.193***	0.179***
	(0.08)	(−1.07)	(11.27)	(4.60)
Log capital intensity	0.0194	0.0309	0.0224***	0.0357***
	(1.80)	(1.30)	(5.30)	(3.88)
Firm debt	0.0589	0.0782	0.0445	0.122
	(1.08)	(0.43)	(1.84)	(1.75)
Liquidity	0.0366	0.486***	0.0700***	0.140**
	(1.30)	(3.56)	(5.75)	(3.21)
Young firm	−0.0814	−0.288	−0.0183	−0.0146
	(−1.78)	(−1.86)	(−1.11)	(−0.32)
Import status	1.122***	1.428***	1.130***	1.278***
	(35.69)	(12.65)	(91.31)	(38.42)
Foreign owned	0.392***	−0.0809	0.321***	0.149*
	(4.00)	(−0.47)	(9.57)	(2.16)
West	−0.177***	−0.0845	−0.0679***	−0.0652
	(−4.60)	(−0.73)	(−4.09)	(−1.50)
North	−0.256***	−0.187	−0.241***	−0.307***
	(−4.56)	(−0.97)	(−8.70)	(−3.91)
South	0.210***	0.0414	0.208***	0.187***
	(5.01)	(0.34)	(11.23)	(3.81)
No. of obs.	40,766	3966	203,304	22,570
R^2	0.297	0.293	0.34	0.375

Notes: Results based on probit model in the form of equation (1) for the years 2010–2016.The sample is split by productivity, with the 10% most productive firms in each industry-year included in the high-productive sample. Sector-year dummies are included in all specifications (NACE 2-digit). NUTS1 region East is dropped as spatial dummy. Standard errors are clustered on a firm level. A joint test rejects the equality of the coefficients between columns (1) and (2) as well as columns (3) and (4). * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

Table A6. Factors that contribute to a firm starting to export.

Variable	Manufacturing sector		Services sector	
TFP	0.305**	−0.00358	0.147***	−0.0116
	(3.14)	(−0.03)	(5.00)	(−0.34)
Log sales		0.236***		0.108***
		(6.07)		(9.75)
Log skills		−0.136		0.106***
		(−1.36)		(3.91)
Log capital intensity		0.0105		0.0110
		(0.49)		(1.69)
Firm debt		0.172		0.0166
		(1.58)		(0.43)
Liquidity		0.0766		−0.00231
		(1.25)		(−0.11)
Young firm		0.219**		0.143***
		(2.65)		(5.69)
Import status		0.370***		0.378***
		(6.47)		(17.76)
Foreign owned		−0.115		0.265***
		(−0.47)		(4.43)
West		−0.0822		−0.0282
		(−1.13)		(−1.13)
North		−0.104		−0.133***
		(−1.08)		(−3.33)
South		0.0990		0.150***
		(1.20)		(5.17)
No. of obs.	5884	5884	68,567	68,567
R^2	0.06	0.10	0.09	0.11

Notes: Results based on probit model in the form of equation (2) for the years 2010–2016. The analysis is similar to Table 5, but then unconditional on productivity. NUTS1 region East is dropped as spatial dummy. Standard errors are clustered on a firm level. * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

Table A7. Robustness analysis: adding region-year dummies to Table 5.

	Manufacturing				Services			
Variables	Low/medium productive		Highly productive		Low/medium productive		Highly productive	
Log sales	0.248***	0.248***	0.195*	0.212**	0.108***	0.108***	0.101***	0.102***
	(5.69)	(5.68)	(2.58)	(2.76)	(7.79)	(7.79)	(5.58)	(5.60)
Log skills	−0.0957	−0.0969	−0.171*	−0.193*	0.113***	0.113***	0.103*	0.102*
	(−0.80)	(−0.81)	(−0.94)	(−1.04)	(3.32)	(3.32)	(2.25)	(2.23)
Log capital intensity	0.0440	0.0440	−0.0566	−0.0592	−0.0013	−0.0013	0.0302**	0.0299**
	(1.67)	(1.66)	(−1.47)	(−1.51)	(−0.15)	(−0.17)	(2.86)	(2.83)
Firm debt	0.0842	0.0834	0.506*	0.514*	0.0654	0.0655	−0.0680	−0.0667
	(0.67)	(0.67)	(2.00)	(2.01)	(1.47)	(1.47)	(−0.89)	(−0.87)
Liquidity	0.112	0.113	−0.128	−0.140	−0.00413	−0.00348	−0.0242	−0.0235
	(1.69)	(1.69)	(−0.71)	(−0.76)	(−0.18)	(−0.15)	(−0.54)	(−0.52)
Young firm	0.228*	0.226*	0.217	0.205	0.118***	0.119***	0.196***	0.18***
	(2.49)	(2.46)	(0.99)	(0.92)	(4.00)	(4.02)	(4.10)	(4.14)
Import status	0.345***	0.346***	0.501***	0.520***	0.378***	0.382***	0.382***	0.381***
	(5.31)	(5.33)	(3.65)	(3.75)	(14.65)	(14.65)	(10.09)	(10.08)
Foreign owned	0.006	0.008	0.114	0.073	0.318***	0.318***	0.199*	0.199*
	(0.01)	(0.02)	(0.39)	(0.25)	(3.99)	(3.98)	(2.18)	(2.18)
West	−0.147		0.142		−0.0098		−0.0728	
	(−1.80)		(0.82)		(−0.33)		(−1.61)	
North	−0.175		0.172		−0.0868		−0.262***	
	(−1.62)		(0.69)		(−1.84)		(−3.42)	
South	0.0906		0.178		0.178***		0.0910	
	(0.97)		(0.93)		(5.16)		(1.67)	
Region-Year dummies	No	Yes	No	Yes	No	Yes	No	Yes
No. of obs.	4756	4756	962	962	47971	47971	20495	20495
R^2	0.11	0.11	0.11	0.13	0.11	0.11	0.13	0.13

Notes: Results based on probit model in the form of equation (2) for the years 2010–2016.The sample is split by productivity, with the 30% most productive firms in each industry-year included in the high-productive sample. NUTS1 region East is dropped as spatial dummy. Sector-year dummies are included in all specifications (NACE 2-digit). Standard errors are clustered on a firm level. The *t*-statistics are reported in brackets. High-productive firms form slightly less than 30% of the observations, due to the fact that we only include non-exporters. A joint test rejects the equality of the coefficients between columns (1) and (2) as well as columns (3) and (4). * represents significance at 5% level, ** at 1% level and *** at 0.1% level.

Appendix 4. Out of sample testing for dynamic model

In order to assess the relevance of the estimated model for policy purposes, we perform an out of sample test in which we examine how well the model can predict the future exporters. Specifically, we estimate a model identical to specification of Table A6, which predicts the probability that a non-exporter exports in $t+2$, for the years 2010 and 2011. The coefficients from this regression are used to estimate the probability that non-exporters in 2012, 2013 or 2014 will be exporting two years later (in 2014, 2015 and 2016 respectively).

The figure below shows the predicted probabilities (x-axis) compared with the realization (y-axis). In order to construct the figure above, we have calculated and plotted for each probability group (say all firms with a 20% chance of starting to export according to the model) the percentage of firms that actually started exporting. As the number of firms per probability percentile grows very small in the tails, we used 50 observations per probability percentile as the cut-off value for the points in the scatterplot.

It becomes clear from the figure that our model works rather well, the export probabilities estimated by the model are in line with the export decisions of firms. Unfortunately, it is not possible to identify firms with a 'certainty of exporting', as the highest export probability is around 30%. Nonetheless, a large majority of the firms lies between the 0 and 10% export probability, which thus can be excluded as interesting targets for policy aimed at improving export performance.

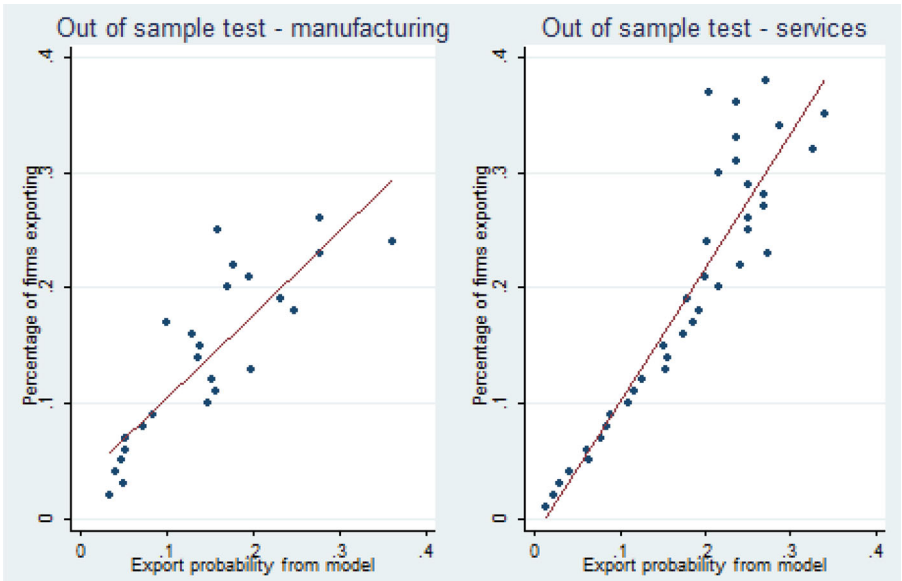


Figure A4. Out of sample predictive power. Panel A – Manufacturing, Panel B – services.

Notes: Model estimated based on columns (2) and (4) of Table A6 for the firms observed in the year 2010–2011 (excluding year dummies). The model is then applied to the firms observed in the years 2012–2014 to predict the probability that these firms will be exporting two years later. The firms are grouped into bins based on their export probability, as displayed on the x-axis. The y-axis displays the actual percentage of firms of the bin that indeed exports two years.